

Lovett

The Affections of the Arch of the
Foot commonly classified
as Flat-foot.

BY

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BOSTON.

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THE
AFFECTIONS OF THE ARCH OF THE FOOT
COMMONLY CLASSIFIED AS FLAT-FOOT.*

BY R. W. LOVETT, M. D., AND

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THE present paper must be considered as a preliminary one and not as a full discussion of the question of flat-foot. It is the desire of the writers to call attention to certain subdivisions which might profitably be made in those anomalies of the arch of the foot which have heretofore for the most part been spoken of as "flat-foot"; to note certain imperfections in the methods of studying these conditions; and to mention some methods of treatment which have been found of use. The study of the conditions presented in this paper must necessarily be desultory and incomplete, but so large was the field opened by the line of investigation taken up that it seemed best to offer for your consideration the points already elaborated and to ask your assistance in the further working out of the problem

* Read before the American Orthopaedic Association, at Chicago, September 18, 1895.

which is presented. The treatment of the severer cases of flat-foot which has been so ably discussed by Dr. Whitman will not be considered in this connection.

The Foot at Birth.—The foot of the infant at birth is not flat, although it is so described even in modern anatomies.* At birth, the arch is, in reality, well formed, and the scaphoid lies from 1·5 to two centimetres above the plane of the heel. The tracing of the foot of an infant premature at seven months, and the photographs of the foot intact and dissected, have been described by one of the writers in Dr. Rotch's book on *Pædiatrics*. The tracing of the foot of an infant premature at seven months, and raised in an incubator, shows an arch of nearly the adult type, and the scaphoid lies 1·8 centimetres above the level of the heel.

It seems as if after birth there forms under the arch of the foot a pad of fat, which is apparently Nature's mode of

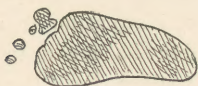


FIG. 1.—Ordinary type of foot imprint tracing in infants.

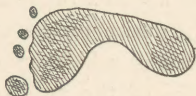


FIG. 2.—Type of tracing in a thin infant a year and eight months old.

preventing the arch from breaking down. The real arch is not lowered and the scaphoid is above the plane of the heel, but the foot appears flat if an imprint is taken of it on account of the development of this pad of fat. It would seem as if for the first year or two Nature provided this mechanical cushion to support the arch. In thin children the print of the foot at this age is not that of a flat-foot but of the normal adult arch.

* Walsham and Hughes. William Wood Company, New York, 1895.

At four or five years the fat is absorbed and the arch again appears in the imprint tracing. A tracing convex on the inside points to the existence of a real valgus or flat-foot. In short, the normal foot in children exhibits at birth a well-formed arch, as shown by the tracing. In fat children, from two to four or five years old, the tracing is that of a foot apparently flat. At four or five years old the arch should appear again in the tracing.

The Study of the Arch.—The study of the arch of the



FIG. 3.—Type of tracing described as normal.

foot and its variations from the normal have for the most part been made by a study of the imprint of the foot as

shown upon a piece of smoked cardboard, or by the imprint of the wet sole on a piece of paper or on the floor. It is our particular object to call your attention to the fact that this method of studying the breaking down of the arch of the foot is a very imperfect one and subject to wide error, for the reason that certain grades of painful affection ordinarily called flat-foot may entirely escape detection. For example, take such a case as the following:

A woman, twenty seven years old, has pain after being on her feet constantly, which has lasted two years and extends to the knee and hip. It has been so severe that there is much swelling of the feet at times. Inspection shows

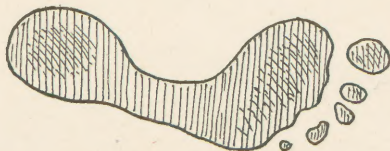


FIG. 4.—Tracing of pronated and painful foot.

plainly enough what we may speak of as pronation of the foot—that is, a prominence of the internal malleolus and rolling out of the foot (in relation to the leg)—but the smoked tracing shows an imprint which any one would consider normal. The patient was then photographed in the following way. A long exposure plate was used, and for the first half of the exposure she stood with the muscles all contracted to hold the foot in the correct position (that is, with the line of the leg passing through the second metatarsal). In the second half of the exposure the foot was allowed to assume its natural position. It may be seen by looking at the drawing that there are two distinct positions, one with the foot in the normal position and the other with the foot in the pronated position. With pronation is neces-

sarily associated anatomically, as may be seen in the drawing, an abduction of the forward part of the foot.

Here, then, is a case of painful difficulty in the feet, accompanied by a marked degree of pronation at the ankle joint, which is not shown by any abnormality of the smoked tracing.

The excursion made by the internal malleolus when the foot gives way under these circumstances was measured in some cases. In the case of a man, twenty-eight years old, who had pronation of the foot for a year, and where under



FIG. 5.—Outline drawing of a foot from a photograph in normal and pronated position, showing the inward excursion of the internal malleolus.

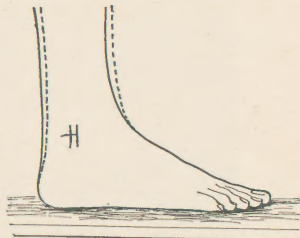


FIG. 6.—Outline drawing of a foot from a photograph in normal and pronated position, showing the forward excursion of the outline over the external malleolus in the pronated position, as shown in the dotted outline.

fatigue and constant overwork a painful condition was rapidly developing, the measurement was made. The foot was placed against an upright without weight bearing. The distance from the upright to the internal malleolus and to the scaphoid was measured. The weight was borne upon the leg and the measurement was made again in the pronated position. Every care was taken to have this measurement accurate, and it was found that the internal malleolus fell in 0·8 centimetre, while the internal surface

of the scaphoid fell in 0·7 centimetre. Measurements of value could not be taken from the external malleolus because, as shown in the photograph of this patient, the external malleolus travels forward with the pronation of the foot.

To study abnormalities of the arch of the foot by means of the smoked tracing alone is as if one were studying



FIG. 7.—Tracing of a flat-foot. No symptoms, foot useful.

typhoid fever with a thermometer which did not register below 101° . This would be quite sufficient to detect the severer grades of fever, but it would entirely overlook slight rises of temperature. This condition should be

spoken of as "pronated foot." It is not flat-foot, because the arch has not broken down, and it would seem best to reserve the term of flat-foot for cases where the imprint of the foot showed a real lowering of the arch. It would be very desirable to find some means of measuring this pronation. Possibly estimating the height of the internal malleolus from the ground in relation to the length of the foot may be of some use in the future, but so far the writers have been unable to devise any satisfactory method of mathematically estimating this condition. In the experience of the writers the pronation of the foot is the one element that seems to bear relation to the amount of pain in practically all troubles with the arch of the foot, whether the arch is broken down or not, and to the study of this they would beg to direct attention rather than to imprint tracings.

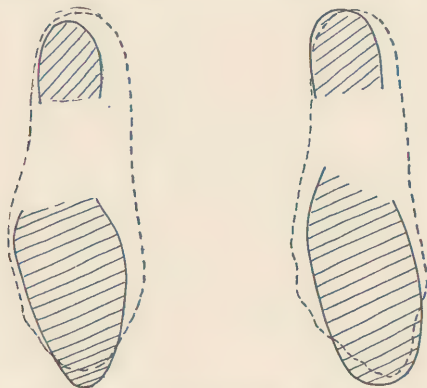
The *symptoms* of pronated foot and flat-foot are the same at the onset. The pain and other symptoms vary more in relation to the amount of pronation than in relation to the breaking down of the arch. This fact has been overlooked. The earliest symptom is generally to be found in weariness and discomfort on long standing. The feet feel hot and flushed and may prickle. The patient is obliged to spare the feet, and there is often difficulty in getting boots to fit. Pain is the commonest symptom; it comes on after long standing and it may radiate up the leg and thigh. It is confined to no especial location. Sensitive spots are generally present. The veins become enlarged and the feet sweat profusely. After resting the feet often feel stiff and clumsy. Patients begin to walk with the feet everted and tread over the inside of their boots. The gait is clumsy and lacks elasticity. Swelling of the feet and legs may occur and abduction of the forward part of the foot is rendered likely. Other

symptoms which may be present are backache and sometimes discomfort in the knees, especially in neurasthenic patients; pain and inflammation in the metatarso-phalangeal joint; ingrowing toenail and sometimes bunion. Tenosynovitis of the tendons in front of the external malleolus is a common symptom, especially in rheumatic patients.

The *causes* of pronated foot and flat-foot are the same and will be considered together. Pronated foot, although most often an early stage of flat-foot, is not necessarily so. In general terms, it may be said that either deformity is caused by a disproportion between the weight to be borne and the muscular power which bears it. The occurrence of the deformity is rendered more likely by the shape of modern boots. The immediate causes of these two conditions are the following, in the order of their approximate importance:

1. Bad boots. The most fruitful cause of pronation of the foot is undoubtedly to be found in the use of improper boots. Merely to illustrate the sort of boots that are being worn, the writers would submit the following tracings taken from certain young women applying for the position of nurse at a hospital where they are under the inspection of one of the writers. In each case the foot was placed upon the ground and weight borne upon it, and an outline in pencil was drawn around the foot. The boot was then placed upon the same paper and the outline of the boot drawn in another color. The diagrams illustrate the relation between the sole of the foot and the sole of the boot. They are not extreme instances, but represent merely average tracings selected from about a hundred at the writer's disposal. They illustrate the sort of boots that are being constantly worn, which must necessarily do much harm. They do harm by throwing the big toe outward, crippling

the feet, not only by squeezing the metatarsal bones together, but by impairing the usefulness of the flexor longus hallucis, which can only work to proper advantage when



FIGS. 8 and 9.—Feet and boots, tracings. The boots are shaded.

the great toe is in line with the inside of the foot. This displacement outward of the great toe deprives the foot of its legitimate inside support, the support which should keep it from rolling over and pronating.

In a perfect foot Meyer's line should pass through the central point of the heel. This line is a prolongation backward of the axis of the great toe. One hundred imprint tracings were taken from applicants for the position of firemen and policemen, by the kindness of Dr. Morton Prince, at the office of the Civil Service Commission, Boston, and they were studied with regard to this position of the great toe. The applicants were naturally from the middle class, where the men were likely to have worn large boots, and to have been as likely to develop the normal foot as any class in the community. Yet in no one of the cases could a line be drawn backward from the great toe which

would have fallen even within the outer border of the heel. In a series of one hundred tracings of nurses the deviation of the great toe was still more noticeable. If one reflects upon the symmetrical shoes which children wear, with the

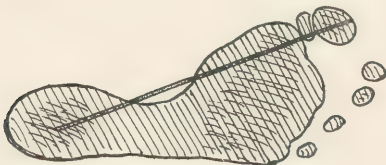


FIG. 10.—Meyer's line in a normal foot.

inside and outside alike, it must be obvious that this process of displacing the great toe outward begins in early childhood. It is to this matter that we would especially call your attention in speaking of boots, as it seems as if

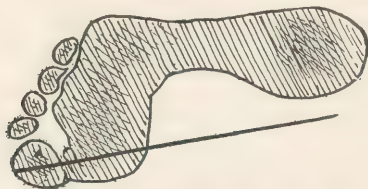


FIG. 11.—Meyer's line in an average foot.

modern footwear deprived the foot of a legitimate support and favored the position of pronation.

2. Weakness or insufficiency of the muscles resulting from—

- (a) Long standing, especially on hard-wood floors.
- (b) Rapid growth.
- (c) Poor health and debility.
- (d) Convalescence from acute illness.

(e) Rapid gain of weight.

(f) Accident or injury causing disuse of limb.

3. Excessive weight-bearing, as in the case of professional strong men and jumpers.

4. A shortened condition of the gastrocnemius muscle, as described by Shaffer. Unless dorsal flexion of the foot beyond a right angle is possible, it is impossible for a person to complete the step with the leg straight behind him and the foot pointing forward. Eversion of the foot is necessary, and a completion of the step by rolling over on to the inner side of the foot. This, of course, tends to produce pronation and breaking down of the arch.

5. Rickets, for the most part to be observed among children.

6. Infantile paralysis.

7. Direct traumatism.

8. Locomotor ataxia and similar organic nervous diseases.

Pronated foot and flat-foot coexist often with rheumatoid arthritis and neurasthenia. There is also a type of intractable flat-foot seen in young adults, accompanied by muscular atrophy, where treatment is of little avail. Its ætiology is most obscure.

"*Contracted foot*" is the term which the writers would apply to a condition described in part by Dr. N. M. Shaffer under the name of non-deforming clubfoot. Contracted foot is characterized by a limitation of the dorsal flexion of the foot, or by an elevation of the arch of the foot, so that the outer border does not rest upon the ground. The latter condition is made evident by an imprint tracing, and the former by passive manipulation of the foot by the leg held straight. Contracted foot may or may not induce pronation of the foot, and in many instances is probably the early stage of flat-foot.

The symptoms are similar to those of flat-foot: Pain and discomfort in the feet in standing, and particularly on walking; pain often located between the fourth and fifth



FIG. 12.—Tracing of a contracted foot. No symptoms, foot useful.

metatarsals, often spoken of as Morton's disease. Pain in the knees and backache are among the common symptoms.

Diagnosis.—The existence of flat-foot can be demonstrated by having the patient step with the wet sole upon the floor or upon a piece of paper, or more accurately by having the patient with the bare foot step upon a piece of cardboard blackened with camphor smoke. In either case the imprint will show whether the arch is normal or whether

it is abnormally high or low. In the former case it is contracted foot and in the latter case flat-foot. If dorsal flexion of the foot is limited at a right angle, contracted foot is present. The presence or absence of flat-foot proper depends entirely upon the study of the imprint tracing.



FIG. 13.—Pronated foot without breaking down of the arch. See tracing.

The existence of pronated foot must for the present be detected by the eye, which will notice whether in standing the line of the leg passes, as it should, through the second toe or the outer side of the first toe when weight is borne upon the foot. It may be noted in passing that in one hundred tracings of nurses studied the condition of contracted foot, as demonstrated by the tracing, existed in one nurse in ten, and that a tracing perfectly characteristic of flat foot existed in the same proportion of cases in one nurse in ten, yet in no one of these apparently abnormal tracings was pain or disability present.

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Treatment.—Pronated foot and flat-foot differ but little in treatment, except that in the former support to the arch



FIG. 14.—Flat-foot—painful. Showing similarity of position to that in Fig. 13.

of the foot is not always necessary. Remedial measures will be considered in order, beginning with the mildest.

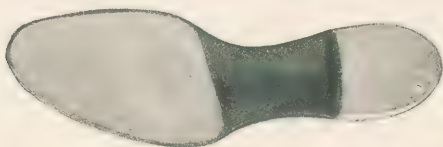


FIG. 15.—Boot of improved pattern (the inner edge is not quite so straight as it should be theoretically).

1. *Boots.*—Proper boots should be insisted upon. The essentials of a good boot are the following:

- (a) A straight, or nearly straight, inside edge.
- (b) The sole of the boot should be as wide as the sole

of the foot when weight is borne upon it, across the front of the foot opposite the metatarso-phalangeal joint.

(c) The shank should not be cut away on the inside, but should be moderately high and should support the arch of the foot.

(d) The forward part of the boot should be at an angle to the back part, so that the foot should be held in the position of adduction. In short, the sole of the boot should be constructed on a curve with the convexity outward. Pronation, it has been seen, is necessarily associated with abduction. Anything which tends to diminish abduction tends to prevent pronation. Consequently, the boot which holds the foot in the adducted position is most likely to prevent the occurrence of pronation.

Practically the same points are essential in the boots for children.

2. *Raising the Inside of the Boots.*—In cases with troublesome pronation, but with no breaking down of the arch of the foot, it is desirable to raise the inner side of the sole and heel of the boot an eighth or a quarter of an inch, or more if necessary. This is done by making the inner side of the sole and heel thicker than the outer side. This throws the foot more to its outer side and changes the bearing of the foot. This may be done whether or not plates or pads are used.

3. *Supports.*—If the arch has broken down, or if raising the inner side of the boot until the correct position of standing is induced is not sufficient, a brace may be applied with a pad over the internal malleolus which shall throw the foot over on to its outer side. A pad or a plate may be applied to hold up the arch of the foot and, by supporting the weight in that way, to throw the foot on to its outer side. In the hands of the writers the use of a simple silicon-bronze plate, accurately shaped to fit the

arch of the foot, has produced the best results. The limits of this plate are shown in the figure. The use of pads of felt or leather, of elastic springs, and of other devices has not, as a rule, been as satisfactory in the hands of the

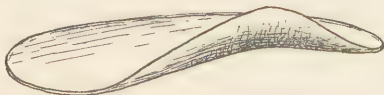


FIG. 16.—Flat-foot plate—right foot.

writers as that of a metal rigid plate. Pads of leather or felt tend to break down the shank of the shoe, and in time to make it convex downward. It is, to our mind, of the greatest importance that the plate should fit accurately, and, if possible, patients should be fitted by the workmen where the plate can be bent hot. This measure has been adopted by the writers because it was found that sore spots in the sole of the foot were not reproduced if the plate was fitted on a plaster cast, and that the comfortable fitting of the plate was a matter of precision only to be obtained in this way. The writers would wish to insist most strongly on this accurate adjustment of the plate. Plates are not applied with the idea of furnishing a permanent support. They are put in, on the contrary, with the idea of being removed as soon as the foot shall have been restored to its normal condition. In certain cases there seems to be what one would almost call a reflex irritation in these feet, which leads to a breaking down of the arch. That is to say, if these feet are padded or soothed by plates or by rest, the arch is, to a certain extent, restored temporarily, and it is a common experience in the use of accurately fitting plates that after a month or so a patient becomes uncomfortable, and it is found by inspecting the marking on the plate that the arch has raised so that the plate fails to support it and

the plate must be arched still more in order to be a support. The writers can recall three recent patients, one a woman weighing one hundred and ninety pounds and the mother of four children, who have been able to go without plates after wearing them from six to ten months. This the writers do not attribute entirely to the use of plates but also to the general treatment.

With regard to the general and local treatment other than the use of proper boots and plates, the writers would wish to lay great stress upon the value of massage and exercises for restoring the use of the muscles at fault. In pronated foot and flat-foot it is common for the circulation to be poor, the veins to be enlarged, the feet to sweat profusely, and for the general circulation of the feet to be in a very unsatisfactory condition. It is obvious under these circumstances that massage and manipulation are strongly indicated, and in cases where these are not obtainable that exercises should be prescribed which should call into activity those muscles which support the arch of the foot and tend to produce an adducted position. Forcible adduction of the forward part of the foot against resistance, rising on tiptoe, and similar exercises are types of the requirements in this respect.

With regard to the treatment of contracted foot, certain cases, especially if acute, are relieved by placing a pad of felt or a metal plate under the abnormally high arch. Other cases are not quieted by this measure, and require stretching of the gastrocnemius muscle by Dr. Shaffer's shoe, a remedy which is also useful in certain cases of pronated foot associated with limitation of dorsal flexion. Patients with contracted foot, as a rule, find comfort in wearing boots with moderately high heels.

It is difficult to present a summary of a paper which at best is only a brief mention of many points. What the

writers would particularly wish to call to your attention are the following points :

There are three well-marked conditions which give rise to much the same symptoms, which are associated with some abnormality of the foot. These are pronated foot, flat-foot, and contracted foot.

Pronated foot and flat-foot are most often favored by bad boots which render the feet vulnerable and improperly supported.

The ætiological relations of contracted foot are entirely obscure.

The treatment of these conditions consists in the use of boots which shall allow the foot to be placed upon the ground in its proper relation and which favor a correct position of standing.

If the arch is broken down, some appliance should be used to support it so that the foot may rest in the proper position.

These appliances are used merely as temporary measures, and should only be applied in connection with exercises and manipulation intended to restore the muscles to their normal function.

The New York Medical Journal.

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EDITED BY

FRANK P. FOSTER, M.D.

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